Ballantine
Electronic Voltmeter
300G

INSTRUCTION BOOK

for

BALLANTINE MODEL 300G SENSITIVE ELECTRONIC VOLTMETER

BALLANTINE LABORATORIES, INC.
BOONTON, NEW JERSEY

Printed in U.S.A.

2-66-Y-6

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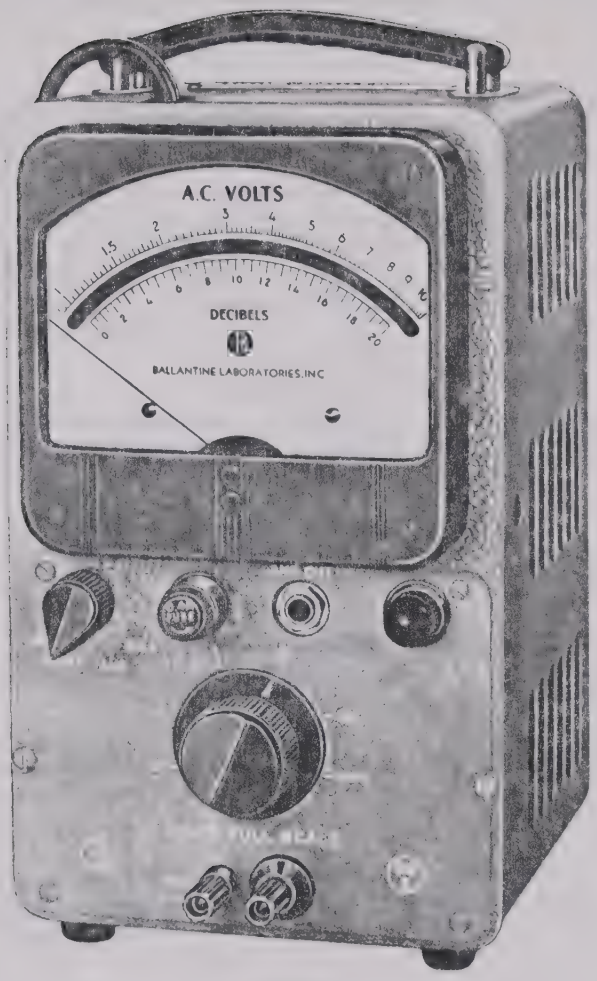


Fig. 1 Ballantine Model 300G
Sensitive Electronic Voltmeter

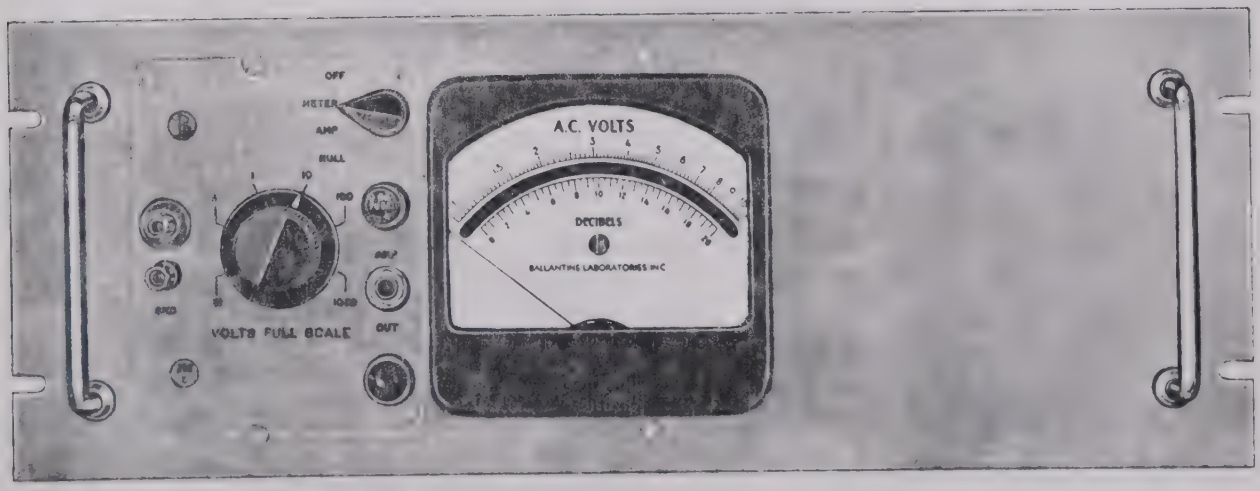


Fig. 2 Model 300G-S/2, Rack Mounted Version

1. SPECIFICATIONS

Voltage Range

1 millivolt to 1000 volts rms in 6 decade ranges (0.01, 0.1, 1, 10, 100, and 1000 volts full scale)

Frequency Range

10 to 250,000 cps

Accuracy

20 cps to 20,000 cps, 1 millivolt to 250 volts 1%
10 cps to 250,000 cps, 1 millivolt to 1000 volts 2%
at all points of the meter scale

Input Impedance

2 megohms shunted by 15 pF except 25 pF on most sensitive range

Decibel Range

—60 to +60 decibels referred to 1 volt

Stability

Less than ½% change with power supply voltage variation from 105 volts to 125 volts

Scales

Logarithmic voltage scale reading from 1 to 10 with 10% overlap at both ends, auxiliary linear decibel scale reading from 0 to 20

Tubes

Four 6AU6WA, one 0A2, and one 6X4

Amplifier Characteristics

Maximum voltage gain of 60 db; maximum output of 10 volts; output impedance approximately 300 ohms; frequency response flat with 1 db from 10 to 250,000 cps

Power Supply

115/230 volts, 50-420 cps, 35 watts approximately

Standard Finish

Panel gray crackle, box gray wrinkle

Dimensions

Portable: 11″ H, 6″ W, 7″ D
Rack: 6-31/32″ H, 19″ W, 6″ D

Weight

Portable, 10 lbs.; Rack, 11 lbs.

Shipping Weight

Portable, 13 lbs.; Rack, 26 lbs.

2. GENERAL DESCRIPTION

The Model 300G Voltmeter has been designed to permit enhanced measurement accuracy of ac voltages from 1 millivolt to 1000 volts over a frequency of 10 cps to 250 kc.

The instrument comprises an input attenuator followed by a degeneratively stabilized amplifier which feeds an average responding rectifier circuit. Current from the rectifier circuit passes through a moving coil meter, which has the logarithmic voltage and associated linear decibel scales characteristic of other well-known Ballantine voltmeters. The voltage is read with the *same accuracy throughout the entire meter scale.*

By rotating a function switch, the amplifier output may be disconnected from the rectifier circuit and made available at an output jack on the front panel of the instrument. The function switch also serves to turn the instrument on and off.

3. OPERATION

3.1 Power Connection and Warmup

Connect the power cord to a source which conforms with the requirements stated on the decal located where the line cord leaves the instrument case. Rotate the function switch to either the METER or AMP position and note that the pilot lamp lights. Allow a warmup period of several minutes, unless the instrument has not been in use for many months, in which case allow an initial warmup period of at least 30 minutes.

IT IS IMPORTANT THAT AIR BE ALLOWED TO CIRCULATE FREELY AT ALL SIDES OF THE INSTRUMENT AND THAT NO SOURCES OF HEAT BE PLACED DIRECTLY AGAINST THE INSTRUMENT CASE.

3.2 Voltage Measurement

Rotate the function switch to the position marked METER. Connect the voltage to be measured to the input terminals observing the *ground* polarization. Rotate the range control until an on-scale indication is observed. The position of the range knob, together with the meter indication, gives the value of the voltage at the input terminals.

If a dc component is also present when making ac measurements, care must be taken to insure that this dc component does not exceed 600 volts (dc working voltage of input coupling capacitor). In the event that the dc component exceeds this value, an additional blocking capacitor, with the necessary dc working voltage may be placed in series with the input terminal. At low frequencies the value of this capacitance must be large enough (0.5 μF at 10 cps) to prevent degradation of the low frequency accuracy of the voltmeter.

For greatest accuracy the instrument should be used in its vertical position, the position in which it is calibrated at Ballantine Laboratories, Inc. When used in the horizontal position, balance error in the indicator may result in reduction of accuracy. This effect, if present, is usually greatest at the low end of the scale and may be reduced by a readjustment of the *Scale Adjustment* as outlined in Section 5.2.

It is also recommended that for measurements demanding the greatest accuracy the portion of the scale between 1 and 11 be used, avoiding the overlap region of 0.9 to 1.0, where meter friction, temperature effects, noise, etc., may cause additional error.

Although great precautions in design and construction have been taken to minimize the inherent hum in this instrument, signal of the line frequency amounting to several microvolts referred to the input terminals is present. If the highest accuracy is needed when making measurements of signals at line frequency, the average of the two indications obtained with the line plug in both its positions should be taken.

Although the instrument is designed to withstand rather severe overloads without damage, there are limits to the amount of overloading which may be safely imposed. In general, on the lower ranges, this is dictated by the maximum grid voltage which the amplifier input tube can withstand without damage. On the higher ranges the maximum voltage rating of components in the input attenuator restricts the maximum voltage which may be safely applied. Table I below lists the maximum overload ratios for the various ranges.

TABLE I

MAXIMUM OVERLOAD RATIOS

Range	*Overload Ratio*	*Maximum Input*
0.01 volt	10,000 to 1	100 volts
0.1 volt	1,000 to 1	100 volts
1.0 volt	1,000 to 1	1000 volts
10.0 volts	100 to 1	1000 volts
100.0 volts	10 to 1	1000 volts
1000.0 volts	1 to 1	1000 volts

3.3 Current Measurement

By using the Ballantine Series 600 Precision Shunt Resistors in conjunction with this voltmeter it is possible to measure ac currents from 1 microampere to 10 amperes. For a complete description of the accuracy, current, and frequency range of these shunt resistors, refer to the Ballantine catalog

3.4 Input Impedance

At low frequencies the input terminals present a constant resistive component (2 megohms $\pm$ 1%) to the input signal, while the capacitive component is a function of the range switch setting and is given in Table II. Although the capacitive component is essentially independent of frequency, the resistive component changes as the higher frequencies are approached. Figure 3 shows the approximate variation of input resistance vs. frequency. It will be noted that on all except the most sensitive range the input resistance decreases with frequency. On the most sensitive range, the input resistance increases at the higher frequencies, eventu-

ally becoming negative. Connecting the input terminal across an LC circuit which has its resonant frequency in this region may result in oscillation. This may be eliminated by connecting a small resistor (several hundred ohms) in series with the high input terminal.

TABLE II

INPUT CAPACITANCE VS. RANGE SWITCH SETTING	
Range	*Capacitance*
0.01 volt	25 pF
0.1 volt	15 pF
1.0 volt	15 pF
10.0 volts	15 pF
100.0 volts	15 pF
1000.0 volts	15 pF

3.5 Use As Amplifier

Rotate the function switch to the position marked AMP. Connect the signal to be amplified to the input terminals, observing ground polarization. Rotate the range control to the range which would be used in measuring the input voltage. The output is now available at the output jack located on the front panel and marked AMP OUT.

The maximum voltage gain of the amplifier is 60 db, reducible in steps of 20 db by means of the range switch.

The maximum output voltage available is 10 volts, while the output impedance is approximately 300 ohms at midband frequencies. A distortion-free output is obtainable with load impedances as low as 15,000 ohms. The open circuit noise level referred to the input terminals will in general be under 40 microvolts for the most sensitive range and under 30 microvolts for all other ranges. The response

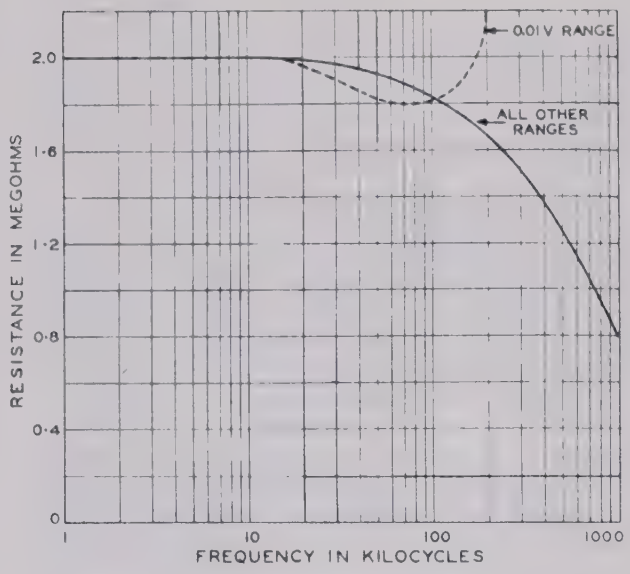


Fig. 3 Input Resistance vs. Frequency

of the amplifier is flat within 1 db over the range of 10 cps to 250,000 cps, for load impedance of not less than 15,000 ohms.

3.6 Use as Null Detector

When the function switch is rotated to the position marked "NULL," the instrument may be employed to observe potentials which would ordinarily fall below 1 on scale on the most sensitive range (1 millivolt). This is accomplished by biasing the meter indication to an on-scale position even in the absence of signal. It should be noted that in this function the instrument indicates only the relative magnitude of potentials and not absolute values.

4. CIRCUIT DESCRIPTION

A schematic diagram and replacement parts list are included at the end of this instruction book.

4.1 Input Attenuator

Since the amplifier of the Model 300G always operates with the same basic sensitivity (0.001 volt to 0.01 volt), an attenuator must be provided for reducing higher level voltages to this range.

TABLE III

ATTENUATOR RATIOS	
Range	*Attenuation Ratio*
0.01 volt	1
0.1 volt	10
1.0 volt	100
10.0 volts	1,000
100.0 volts	10,000
1000.0 volts	100,000

Actually the input attenuator of the Model 300G consists of three separate attenuators. The first provides a reduction of 10 to 1; the second, 100 to 1; the third, 1000 to 1, 10,000 to 1, and 100,000 to 1. Table III is a listing of range switch settings and attenuation ratios.

At very low frequencies the attenuation ratio is determined solely by the resistors employed. At the higher frequencies, capacitive compensation is necessary to compensate for circuit strays, input capacitance of the amplifier, etc. The crossover from resistive to capacitive attenuator occurs at approximately 25,000 cps. Figure 4 is a simplified schematic of all three attenuators showing component values. The high frequency response of attenuator No. 1 is adjustable by means of C2, the response of No. 2 by C4, the response of No. 3 by C6. It will be noted that no compensation is employed on the second and third steps of attenuator No. 3, because of the relatively low resistances involved and the negligible reactive components of the resistors. Thus C6 serves to adjust the high frequency response of all three steps of attenuator No. 3. *Note* — The user is cautioned against making any adjustments of C2, C4, or C6 without first reading Section 5.5.

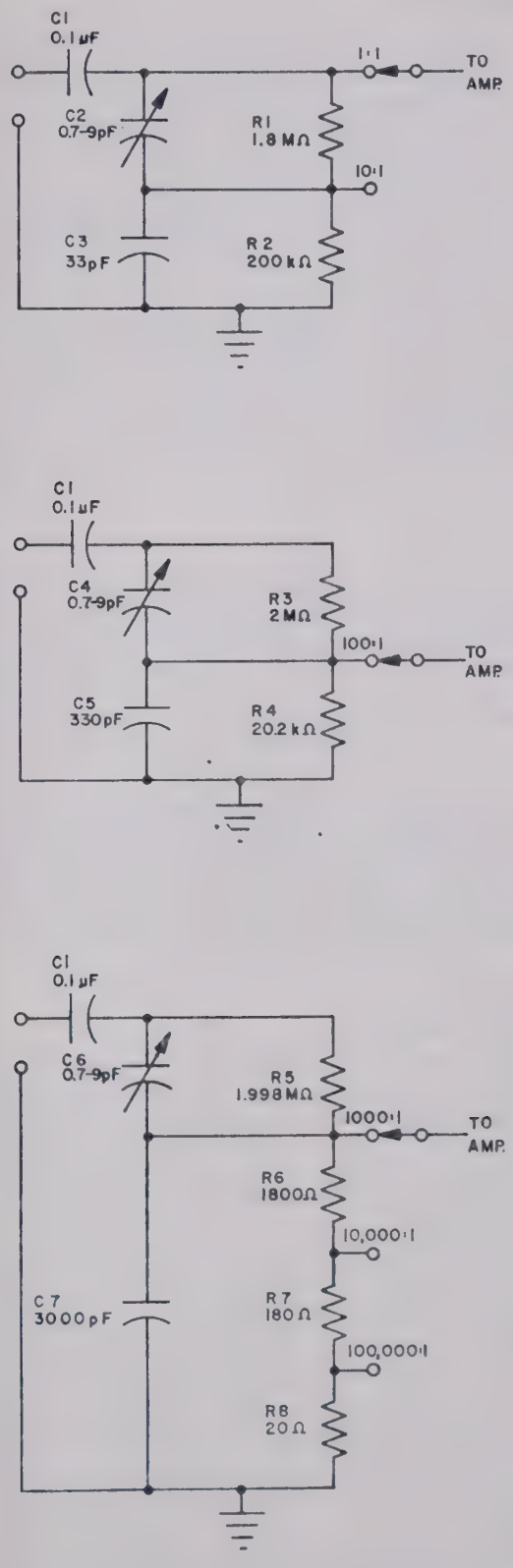


Fig. 4 Attenuator, Simplified Schematic

4.2 Amplifier

The amplifier consists of four capacitively coupled pentode stages. The first three stages are operated to provide voltage gain while the final stage is used as a transducer to convert voltage to current for the rectifier-meter circuit. When the instrument is operated in its AMP position the fourth stage also provides voltage gain.

Local feedback (8 db, or greater, achieved by unbypassed cathode resistors) as well as overall feedback (32 db or greater) is employed to minimize distortion and gain changes from whatever cause. The amplifier response without feedback is shaped to fall off from the midband value at a rate of approximately 6 db per octave. As a result of this and the amount of feedback available, the stability of the amplifier at the band extremes (10 cps and 250 kc) is essentially that of midband.

The high frequency response of the instrument is adjustable over a narrow range by means of L1. See Section 5.5. The gain or sensitivity of the instrument is adjustable over a small range by means of R16 in the feedback network. See Section 5.3.

The heater of the input amplifier stage is operated on dc to minimize the line frequency component injected in this low level stage. Thus the error introduced when measuring voltages of line frequency and its harmonics is substantially reduced.

4.3 Rectifier-Meter Circuit

AC current, available from the last amplifier stage, is passed through the rectifier-meter circuit and the feedback network to ground.

The rectifier is of the full wave bridge type employing semiconductor diodes, and direct current from it passes through Meter M1. The capacitor across M1 serves to reduce the indicator flutter at the lower frequencies. The response of the circuit is average, although the meter is calibrated rms in terms of a sine wave.

Resistors R38 and R40 provide for an adjustment of the meter indication at 1 on scale. See Section 5.2. A small current, determined primarily by the value of R40 and the potential at the top of the rectifier circuit with respect to ground, is passed down through the rectifier circuit. The division and direction of this current through the meter is determined by the position of R38.

The signal rectifiers are hermetically sealed, small area silicon junction diodes which are virtually immune to aging and environmental conditions. The inherently non-linear characteristic of the diode rectifier is reduced to negligible proportions by incorporating the rectifier circuit within the feedback loop.

The meter movement is of special design, employing shaped pole pieces to achieve a logarithmic voltage indication.

4.4 Power Supply

Amplifier plate and screen voltages are obtained from a full wave vacuum tube rectifier employing an RC filter, and gaseous regulator tube. Low voltage dc power for the first amplifier stage heater is obtained from a full wave rectifier employing hermetically sealed silicon junction diodes, and a capacitance filter. All other amplifier heaters are operated on ac balanced with respect to ground.

5. MAINTENANCE AND SERVICE

Servicing of the instrument by the user is feasible, providing the procedures outlined in this section are followed. However, it cannot be too strongly emphasized that the work should be entrusted only to technicians having the highest skill and experience in measurement techniques. A refined and comprehensive method of recalibration is beyond the scope of this manual and cannot be effected without specialized equipment having an order of accuracy much greater than that of the instrument being checked. Such equipment and personnel trained in its use are available in the Calibration Department of Ballantine Laboratories, Inc., so that if trouble develops which cannot be corrected except by the replacement of special components, or if the user is not equipped with the necessary test equipment, it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for servicing. The instrument should in all cases be preceded by a letter indicating the fault or desired service.

5.1 General Instructions

5.1.1 Fuse and Pilot Lamp Replacement — The fuse is of the Slo-Blow type and is rated at 0.4 ampere for 115 volt operation and 0.2 ampere for 230 volt operation. The fuse holder is of the extractor post type located on the front panel.
The pilot lamp, Type 47, is accessible by unscrewing the red plastic cap located on the front panel.

5.1.2 Line Voltage Conversion — It is possible to operate the Model 300G from either a 115 volt or 230 volt line supply. The line voltage for which the instrument is connected on leaving the factory is indicated on a decal located adjacent to the power cord emergence point. To convert from 115 volt to 230 volt operation, or vice versa, see the schematic diagram located at the back of this manual.

5.1.3 General Malfunction — In case of malfunction, as evidenced by insufficient or even absence of instrument response, instability, high hum or noise level, intermittent operation or other disturbance, the first step is to check all tubes, replacing any which exhibit low gm, grid current, shorts, etc.

With all tubes operating normally the voltages at the elements may be measured and checked against Table IV. All measurements should be made with the Model 300G range switch on the most sensitive range, the input terminals short circuited, and the OFF-METER-AMP switch in the AMP position.

NOTE — WITH THE FUNCTION SWITCH IN THE METER POSITION, IT IS POSSIBLE TO DAMAGE THE SIGNAL DIODES, IF THE PLATE OF V4 IS ACCIDENTALLY CONNECTED TO THE CHASSIS OR GROUND. IT IS ALSO POSSIBLE TO DAMAGE THE DIODE, METER, OR BOTH IF VIRTUALLY ANY PORTION OF THE METER RECTIFIER CIRCUIT IS GROUNDED. THE USER IS THEREFORE CAUTIONED TO TAKE EXTREME CARE WHEN MEASURING IN THIS SECTION OF THE INSTRUMENT.

The instrument used to measure dc should have an input resistance of not less than 10 megohms. Any radical departure from the voltages indicated in Table IV may indicate the nature of the trouble.

In the event of a defective component it should be replaced in accordance with the Replacement Parts List located at the end of this manual. If the component or components are not available locally, they may be obtained from Ballantine Laboratories, Inc.

TABLE IV

TUBE ELEMENT POTENTIALS

Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
V1 6AU6	0 to ± 0.1v	1.40v	3.10v	3.10v	56v	62v	1.40v
V2 6AU6	0 to ± 0.1v	1.45v	*3.15v	*3.15v	62v	85v	1.45v
V3 6AU6	0 to ± 0.1v	1.45v	*3.15v	*3.15v	92v	90v	1.45v
V4 6AU6	0 to ± 0.1v	1.55v	*3.15v	*3.15v	74v	120v	1.55v
V5 0A2	150v	0	–	0	150v	–	0
V6 6X4	*360v	–	*6.3v to Pin 4	*6.3v to Pin 3	–	*360v	390v

All measurements made with respect to chassis ground unless otherwise indicated. All voltages DC unless other indicated.
*AC voltages.

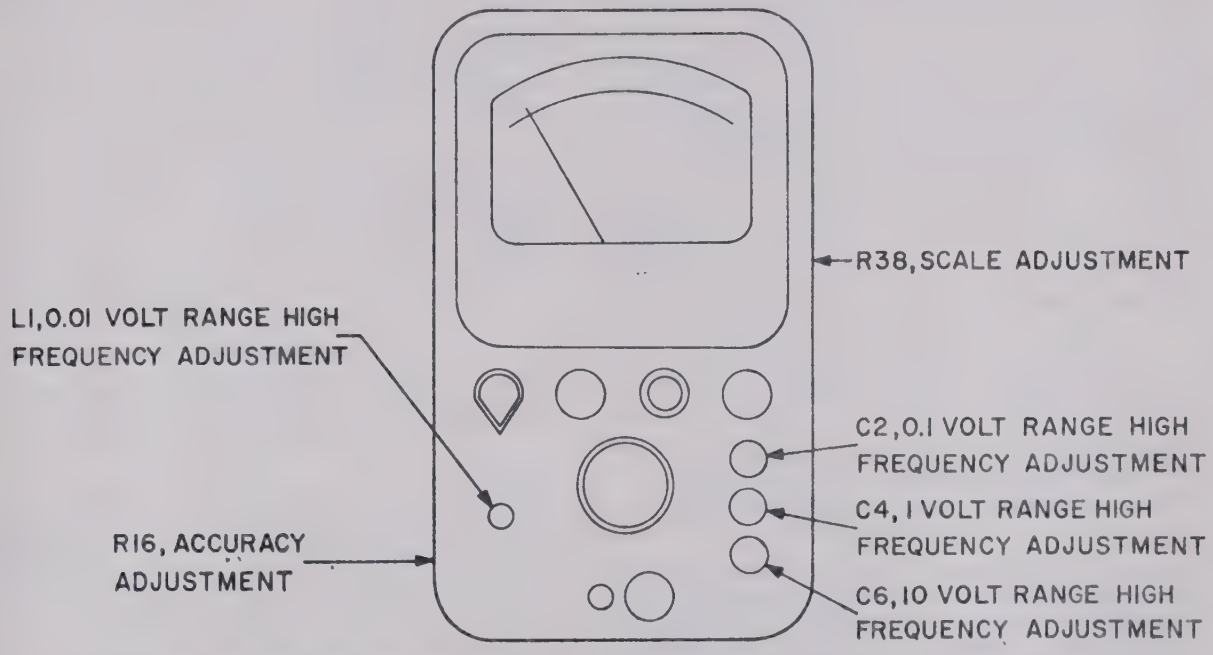
5.2 Scale Adjustment

When an undistorted sine wave signal produces a deflection of precisely 10 on a given range, switching to the next higher range should produce a deflection of precisely 1 on scale. During the instrument calibration at Ballantine Laboratories, Inc., the instrument is very carefully adjusted for this condition and it should seldom, if ever, be found necessary to readjust. In the event that readjustment does become necessary, the control relating thereto is R38, and is available through an access hole in the right-hand side of the instrument case. See Figure 5.

5.3 Accuracy Adjustment

The design of the Model 300G is such that it should maintain its accuracy over extended periods of time and use. At Ballantine Laboratories this accuracy is very carefully adjusted and checked. Moreover, an attempt is made to distribute the various inherent errors so that the best possible overall accuracy results. Therefore, the user is cautioned against making any readjustments without fully determining that the instrument is in error.

All checks of accuracy should be made with an undistorted sine wave signal at a midband frequency (400 - 1000 cps).


R38, SCALE ADJUSTMENT
L1, 0.01 VOLT RANGE HIGH FREQUENCY ADJUSTMENT
C2, 0.1 VOLT RANGE HIGH FREQUENCY ADJUSTMENT
C4, 1 VOLT RANGE HIGH FREQUENCY ADJUSTMENT
C6, 10 VOLT RANGE HIGH FREQUENCY ADJUSTMENT
R16, ACCURACY ADJUSTMENT

Access to L1, C2, C4, and C6 is obtained by removing the two knobs, and then the engraved escutcheon plate.
NOTE — Read Sections 5.2, 5.3, and 5.5 before readjusting any of the above.

Fig. 5 Instrument Adjustments

To make the scale adjustment, connect an undistorted sine wave of midband frequency (400 - 1000 cps) to the input terminals and adjust the amplitude for an indication of precisely 10 on any range (except the 1000 volt range). Switch the attenuator to the next higher range. The indication should be precisely 1. Because of the relatively high damping at the low end of the meter scale, sufficient time should be allowed to permit the indicating needle to come to its final position. It is also recommended that the meter be lightly tapped to remove any effects of pivot friction. If the indication is not precisely 1, correct by means of control R38. Recheck and adjust if necessary.

To reduce the effect of any small balance error which may exist in the indicator, the Scale Adjustment should be made in the same position as the meter is to be used. At Ballantine Laboratories, Inc. all adjustments are made with the instrument in the vertical position.

The external standard meter should be accurate to 0.1% or better, and preferably of the rms responding type.

If it has been established that the instrument is in error, the first attempt at correction should be tube replacement. Access to the tubes may be had by removing the four nickel plated screws along the panel edges, and then removal of the instrument from the instrument case.

If tube replacement does not restore accuracy, a small adjustment is possible with control R16 available through an access hole in the left-hand side of the case. A larger adjustment is possible by changing the value of R17, although the necessity to change this value is good indication that something is at fault in the instrument. See Figure 5.

To adjust the accuracy, first check the Scale Adjustment as outlined in Section 5.2 and readjust if necessary. Next connect an undistorted sine wave signal of midband (400-1000 cps) frequency to the input terminals and check the accuracy at at least 10 points throughout the scale, noting the error and its sign at each point. Readjust R16 so that the maximum positive and maximum negative errors are equal in magnitude.

To reduce the effect of any small balance error which may exist in the indicating meter, the accuracy adjustment should be made with the instrument in the position in which it will be used. At Ballantine Laboratories, Inc. all adjustments are made with the instrument in a vertical position.

5.4 Attenuator Decading

When the input to the instrument is increased or decreased by precise factors of 10, and the range switch is changed accordingly, the indication of the instrument should not vary by more than $\pm 0.1\%$. Thus, if the instrument is reading 5 on a given range, increasing the input by a factor of 10 $\pm 0\%$ and switching to the next higher range should produce an indication of 5 $\pm 0.1\%$. Decading checks should be made with an undistorted sine wave signal of midband frequency (400 - 1000 cps).

There are no controls or adjustments relating to the attenuator decading, this factor being solely determined by the attenuator resistors. If it is discovered that the decading is in error, in all probability one or more of the attenuator resistors has changed in value. However, some other possible sources of difficulty are —

1. Grid current in the amplifier input tube, V1.
2. Misadjustment of capacitors C2, C4 or C6.
   Note — No adjustments of C2, C4 or C6 should be made without reference to Section 5.5.

The resistors employed in the attenuator are hermetically sealed film type of advanced design, exhibiting a stability approaching that of wire wound units but free from the reactive effects inherent in the latter. Initially the resistors are selected to tolerance of $\pm 0.1\%$, in addition the temperature coefficients of the various values are closely matched. In view of the above, it is recommended that the customer make no resistor replacements, except perhaps as an emergency measure on a temporary basis. It is recommended that the instrument be returned to Ballantine Laboratories, Inc. for attenuator repairs.

5.5 High Frequency Response

A discussion of all the factors entering into the high frequency response of this instrument is beyond the scope of this manual. There are however a number of adjustments connected with this response and a procedure for making these adjustments will be outlined. All checks of response must be made with a distortion free sine wave signal, and the instrument used as a reference must have extremely low error over the range of 400 cps to 250 kc.

On the most sensitive range of the Model 300G, the response is determined by the amplifier and rectifier-meter circuit. On all other ranges the attenuator response enters in also.

If it has been determined that the instrument is in error at the higher frequencies, the response of the most sensitive or amplifier range should be checked. If this range is found normal, the trouble must be in one or more of the attenuators employed.

If the most sensitive range response is not normal (variations in excess of $\pm 0.5\%$) the first attempt at correction should be tube replacement. If tube replacement does not restore normal response, a limited amount of adjustment is available by means of variable inductor L1, available through an access hole in the front panel. Removal of the engraved escutcheon plate provides access to L1, C2, C4, and C6 See Figure 5. L1 affects the response only at the higher frequencies and should be adjusted for the flattest response with respect to midband. If adjustment of L1 does not restore normal response, it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for servicing.

If the response of the most sensitive range is normal but errors exist on attenuator ranges, the adjustments are as follows:

1. 0.1 Volt Range — Adjust C2 for flattest response or best agreement with most sensitive range.
2. 1.0 Volt Range — Adjust C4 for flattest response or best agreement with most sensitive range.
3. 10 Volt Range — Adjust C6 for flattest response or best agreement with most sensitive range. The adjustment on this range also takes care of the 100 and 1000 volt ranges.

If the above procedure fails to establish normal response on an attenuator range, capacitors C2, C3, C4, C5, C6, and C7 may be suspect. Access to C3, C5, and C7 may be had by removal of the attenuator shield affixed to the rear of the attenuator switch by means of two machine screw nuts. Access to capacitors C2, C4, and C6 is not possible without removal of the entire attenuator unit. If this appears necessary it is recommended that the instrument be returned to Ballantine Laboratories, Inc. for servicing.

5.6 Low Frequency Response

There are no adjustments relating to the low frequency response. Should trouble be encountered, the following items should be checked:

1. All tubes for gm, grid current, shorts, etc. Tube replacement is the simplest method.
2. All coupling capacitors for proper capacitance and leakage.
3. All plate and screen decoupling capacitors for capacitance.

6. SHIPPING INSTRUCTIONS

If it should become necessary to return the instrument or any part thereof to Ballantine Laboratories, Inc. for examination or servicing, at least 4 inches of packing material should be placed around all sides of the instrument to prevent damage during shipment. Ship via REA Express, motor truck, or air freight and send under separate cover a full description of the trouble or defect. Ship to Ballantine Laboratories, Inc., 90 Fanny Road, Boonton, N. J.

7. REPLACEMENT PARTS LIST

REFER TO MODEL 300G CIRCUIT DIAGRAM, DWG. MD-1392L

B. L. Part No.	*Circuit Symbol*	*Capacitors*	*Manufacturer*
2363	C1	0.1 μF, Type 663-UW, 5%, 600 V	Good-All
2437	C2	0.7-9 pF, Type VC1G	JFD
2235	C3	33 pF, Type CM15-E, 5%, 500 V	Arco
2437	C4	0.7-9 pF, Type VC1G	JFD
2254	C5	330 pF, Type CM15-E, 5%, 500 V	Arco
2437	C6	0.7-9 pF, Type VC1G	JFD
2255	C7	3300 pF, Type CM30-E, 5%, 500 V	Arco
2228	C8	50 pF, Type CM15-E, 5%, 500 V	Arco
2364	C9	0.033 μF, Type 192P, 5%, 200 V	Sprague
2042	C10A	50 μF, Type DFP, 150 V	Sprague
	C10B	50 μF, Type DFP, 150 V	Sprague
	C10C	50 μF, Type DFP, 150 V	Sprague
2240	C11	20 pF, Type CM15-C, 5%, 500 V	Arco
2362	C12	0.22 μF, Type 192P, 5%, 200 V	Sprague
2365	C13	0.01 μF, Type 192P, 5%, 200 V	Sprague
2042	C14A	50 μF, Type DFP, 150 V	Sprague
	C14B	50 μF, Type DFP, 150 V	Sprague
	C14C	50 μF, Type DFP, 150 V	Sprague
2362	C15	0.22 μF, Type 192P, 5%, 200 V	Sprague
2366	C16	0.0022 μF, Type 192P, 5%, 200 V	Sprague
2043	C17A	10 μF, Type DFP, 500 V	Sprague
	C17B	10 μF, Type DFP, 500 V	Sprague
	C17C	10 μF, Type DFP, 500 V	Sprague
2319	C18	2 μF, Type PUP, 5%, 200 V	Cornell-Dubilier
2055	C19	25 μF, Type DPE, 25 V	Sprague
2361	C20	2 μF, Type 663-UW, 5%, 200 V	Good-All
2361	C21	2 μF, Type 663-UW, 5%, 200 V	Good-All
2512	C22	1 pF, Type QC, 5%, 500 V	Quality Components
2044	C23	1,000 μF, Type DFP, 15 V	Sprague
		Resistors	
1476	R1[1]	1,800,000 ohms, Type PT-1000	Ballantine
1441	R2[1]	200,000 ohms, Type PT-500	Ballantine
1477	R3[2]	2,000,000 ohms, Type PT-1000	Ballantine
1442	R4[2]	20,200 ohms, Type PT-500	Ballantine
1478	R5[3]	1,998,000 ohms, Type PT-1000	Ballantine
1443	R6[3]	1,800 ohms, Type PT-500	Ballantine
1444	R7[3]	180 ohms, Type PT-500	Ballantine
1445	R8[3]	20 ohms, Type PT-500	Ballantine
1081	R9	27,000 ohms, Type EB, 5%	Allen-Bradley
1660	R10	47,000 ohms, Type N20, 1%	Corning Glass
1097	R11	47 ohms, Type EB, 5%	Allen-Bradley
1327	R12	5,000 ohms, Type CPX-½, 1%	Aerovox
1085	R13	120,000 ohms, Type EB, 5%	Allen-Bradley
1057	R14	1,000 ohms, Type EB, 5%	Allen-Bradley
1348	R15	250 ohms, Type CPX-½, 1%	Aerovox
1921	R16	10,000 ohms, Type J Pot, 20%	Allen-Bradley
	R17	Value determined in calibration	

[1] Resistors R1, R2 are part of a matched set and must be purchased as Set No. 1597.

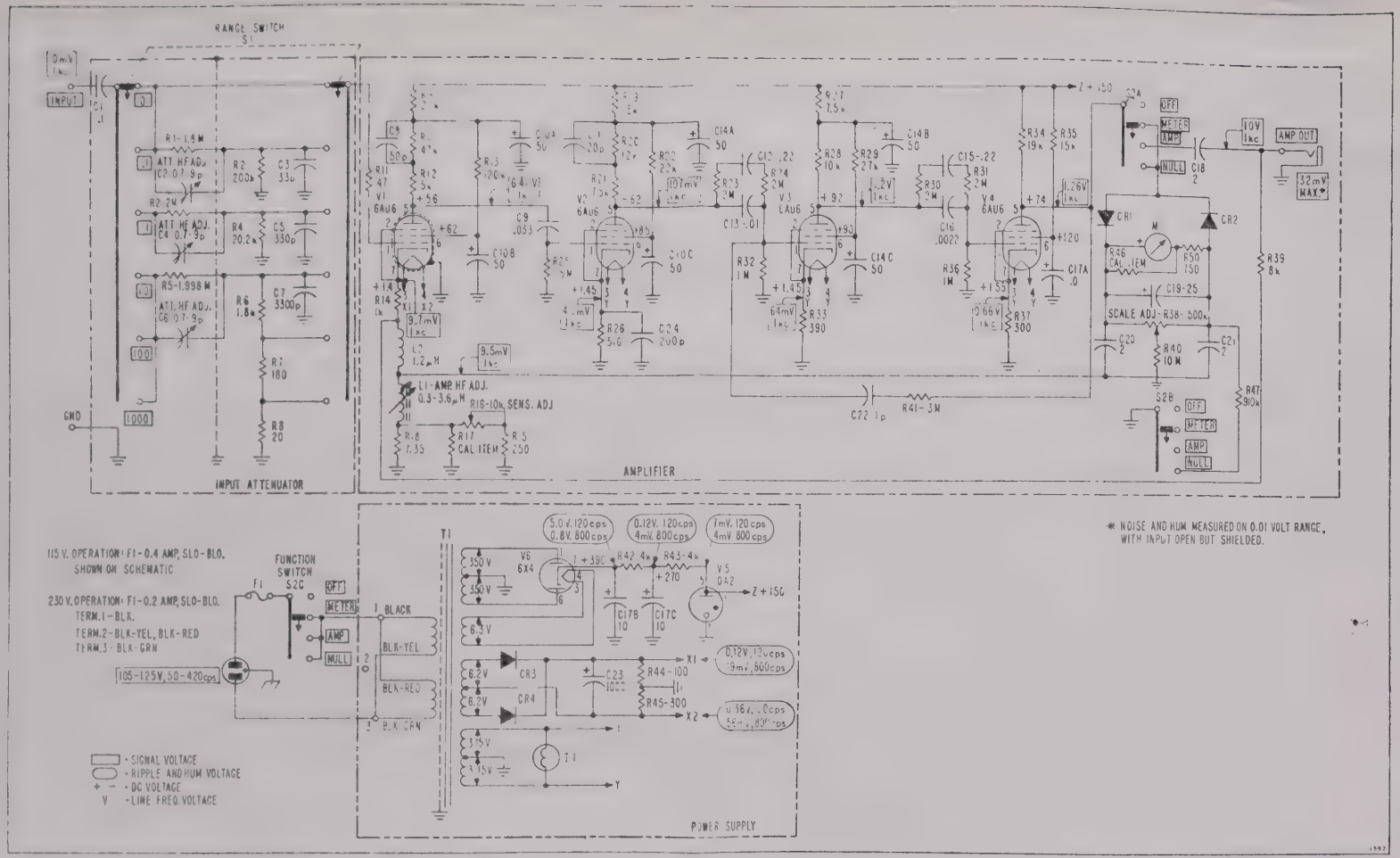
[2] Resistors R3, R4 are part of a matched set and must be purchased as Set No. 1598.

[3] Resistors R5, R6, R7, R8 are part of a matched set and must be purchased as Set No. 1596.

REPLACEMENT PARTS LIST *Continued*

REFER TO MODEL 300G CIRCUIT DIAGRAM, DWG. MD-1392L

B. L. Part No.	*Circuit Symbol*	*Resistors*	*Manufacturer*
1769	R18	7.45 ohms	Ballantine
1042	R19	15,000 ohms, Type EB, 5%	Allen-Bradley
1322	R20	12,000 ohms, Type CPX-½, 1%	Aerovox
1325	R21	7,500 ohms, Type CPX-½, 1%	Aerovox
1039	R22	22,000 ohms, Type EB, 5%	Allen-Bradley
1007	R23	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1007	R24	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1009	R25	1,500,000 ohms, Type EB, 5%	Allen-Bradley
1061	R26	510 ohms, Type EB, 5%	Allen-Bradley
1046	R27	7,500 ohms, Type EB, 5%	Allen-Bradley
1324	R28	10,000 ohms, Type CPX-½, 1%	Aerovox
1081	R29	27,000 ohms, Type EB, 5%	Allen-Bradley
1007	R30	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1007	R31	2,000,000 ohms, Type EB, 5%	Allen-Bradley
1010	R32	1,000,000 ohms, Type EB, 5%	Allen-Bradley
1062	R33	390 ohms, Type EB, 5%	Allen-Bradley
1365	R34	18,000 ohms, Type CPX-½, 1%	Aerovox
1042	R35	15,000 ohms, Type EB, 5%	Allen-Bradley
1010	R36	1,000,000 ohms, Type EB, 5%	Allen-Bradley
1063	R37	300 ohms, Type EB, 5%	Allen-Bradley
1920	R38	500,000 ohms, Type J Pot, 20%	Allen-Bradley
1367	R39	8,000 ohms, Type CPX-½, 1%	Aerovox
1463	R40	10,000,000 ohms, Type CPX-1, 1%	Aerovox
1005	R41	3,000,000 ohms, Type EB, 5%	Allen-Bradley
6164	R42	4,000 ohms, Type 244E4025, 5%	Sprague
6164	R43	4,000 ohms, Type 244E4025, 5%	Sprague
1068	R44	100 ohms, Type EB, 5%	Allen-Bradley
1063	R45	300 ohms, Type EB, 5%	Allen-Bradley
	R46	Is determined in final calibration, not a replacement item	
1011	R47	910,000 ohms, Type EB, 5%	Allen-Bradley
1059	R50	750 ohms, Type EB, 5% (Used only with Westinghouse Indicating Meter)	
		Other Components	
7920	CR1, 2	Diodes, Type 1N4148	G. E.
5559	CR3, 4	Diodes, Type TM1	Transitron
3410	F1	Fuse, 0.4 amp, Slo-Blo	Bussman
3451	I1	Lamp, Type 47	G. E.
3012	L1	Variable Inductor	Ballantine
3068	L2	Inductor, 1.2 μH, Part No. 1840-11, 10%	Delevan
3176	M1	Indicating Meter	Ballantine
3255	S1	Range Selector Switch	Ballantine
3256	S2	Function Switch	Ballantine
3046	T1	Power Transformer	Ballantine
7907	V1, 2, 3, 4	Type 6AU6A Tube, Code 16	R. C. A.
3106	V5	Type 0A2 Tube	R. C. A.
3105	V6	Type 6X4 Tube	R. C. A.
4139	—	AC Power Cord	Ballantine



* NOISE AND HUM MEASURED ON 0.01 VOLT RANGE, WITH INPUT OPEN BUT SHIELDED.

CAPACITORS: NOT MARKED - MICROFARADS (10^{-6}F)
P — PICOFARADS (10^{-12} F)
RESISTORS: NOT MARKED — OHMS (Ω)
K — KILOHMS (10^{3}Ω)
M — MEGOHMS (10^{6}Ω)
VOLTAGES: NOT MARKED — VOLTS (V)
mV — MILLIVOLTS (10^{-3}V)

Fig. 6 Schematic of Model 300G
Dwg. No. MD-1392L

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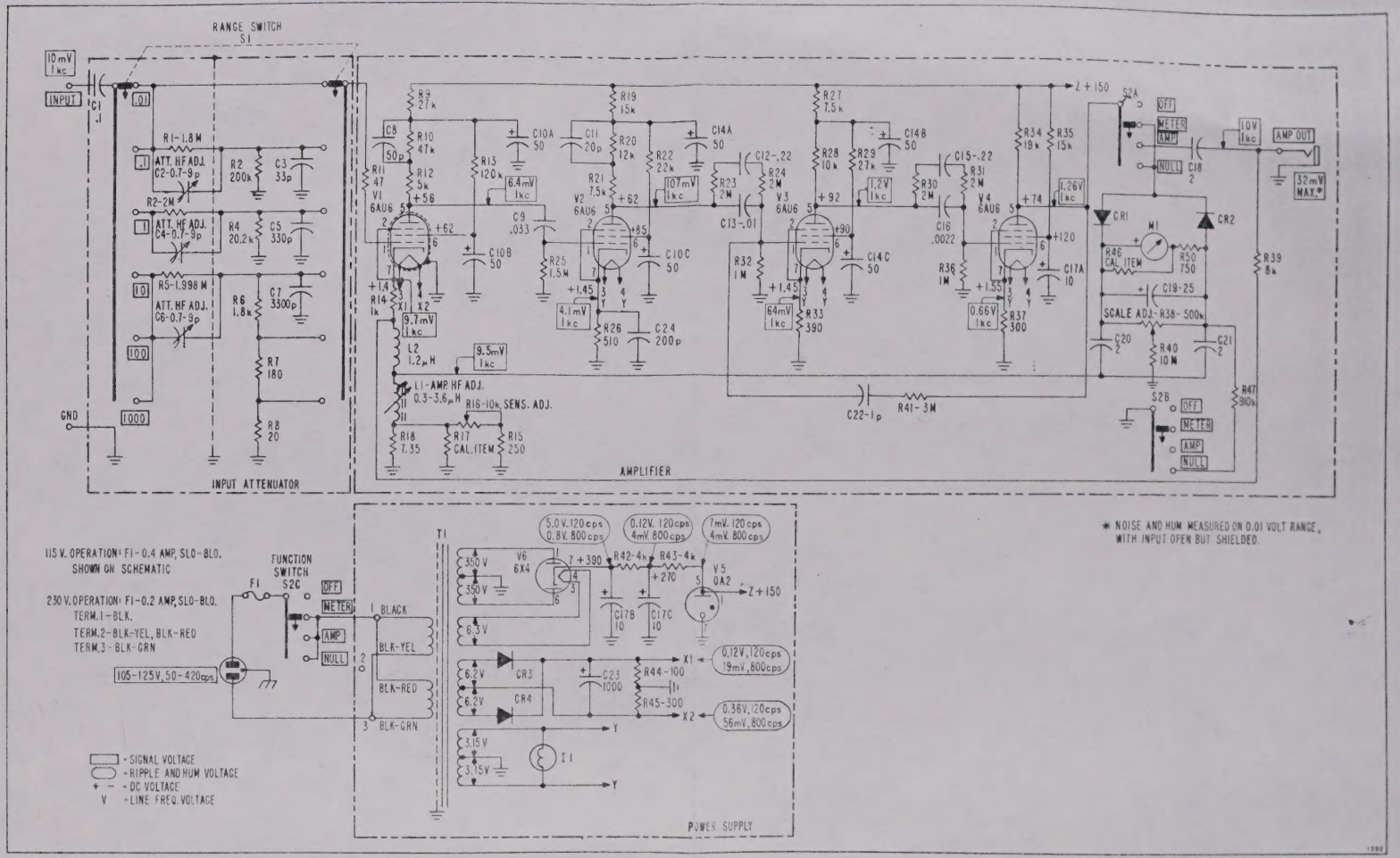

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Fig. 6 Schematic of Model 300G

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